SP2 Liquefaction - Work status and 2021 plans

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Short overall status of the SP

- All WPs are generally on track – slight delays in experimental work
- Publications:
  - Presentations
  - Submitted and planned journal publications – all WPs, some delays
  - Book chapter
  - PhD thesis (3-6 months delay)
- Stakeholder involvement
  - Meetings with stakeholders and discussing results and plans at least twice a year – all WPs
- IEA Task 34 Direct Thermal Liquefaction

SWOT analysis

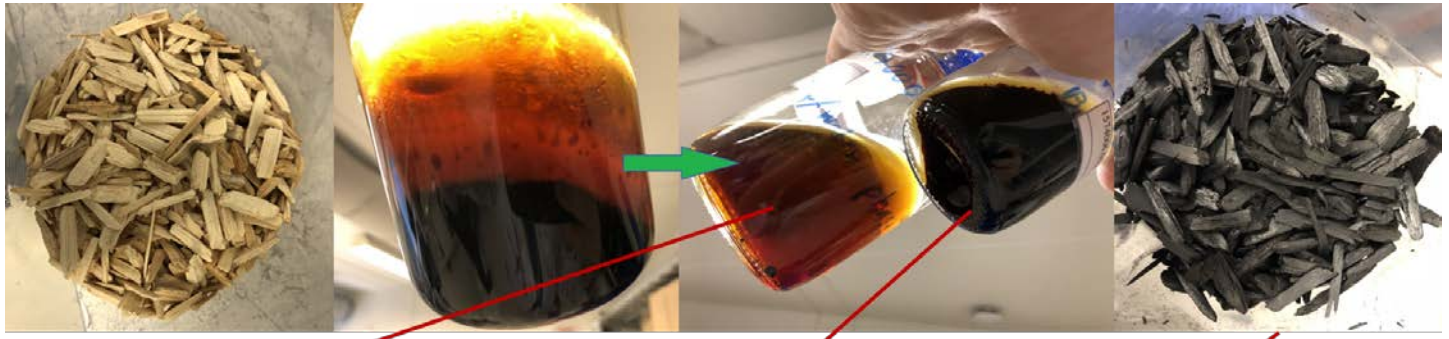
The SPs were not evaluated individually. Some remarks based on the center's evaluation:

- Liquefaction is highly relevant right now
- Strong scientific staff – high quality
- Relevant industry in SP Liquefaction, good collaboration in all WPs
- Several coupled EU projects
- State-of-the-art infrastructure – NorBioLab
- Visibility – communication, internationalization (IEA Task 34, HTL WS, EU projects) but it could be strengthened even more
- Other products and biorefining could be an opportunity

WP 2.1 Pyrolysis - Key Research Tasks

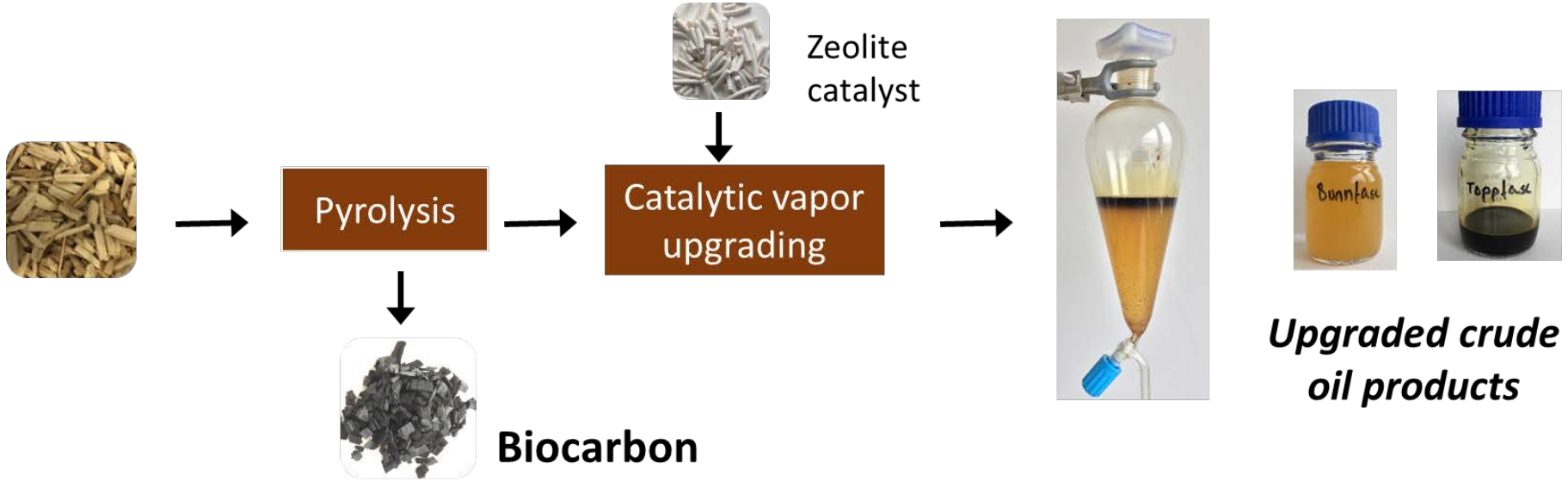
Biomass conversion by pyrolysis and anaerobic digestion

- Coproduction of biocrude, biocarbon and biogas
- Carbon balance established



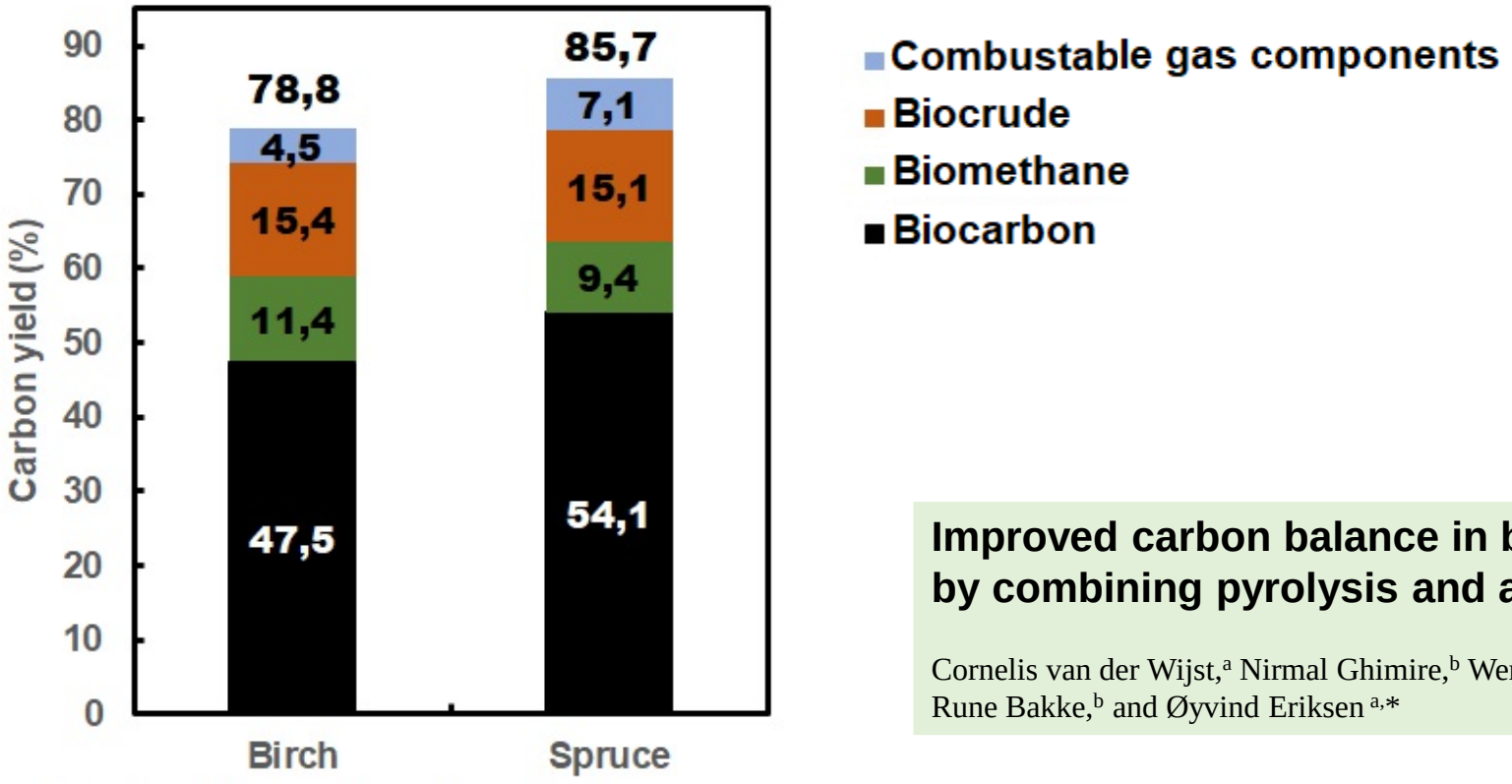
WP 2.1 Pyrolysis - Key Research Tasks

Task 2.1.4 Two step pyrolysis process - Pyrolysis with direct vapor upgrading



WP 2.1 Pyrolysis - Highlights

Biomass conversion by pyrolysis and anaerobic digestion



Improved carbon balance in biocarbon production by combining pyrolysis and anaerobic digestion

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WP 2.1 Pyrolysis – Stakeholder expectations

Stakeholder expectations

- New technology for coproduction of biocrude, biocarbon and biogas by combining pyrolysis technology and anaerobic digestion
- Novel two-step pyrolysis technology for direct conversion of lignocellulose feedstocks into a biocrude quality which is suitable for upgrading to a "drop in fuel" for marine or aviation fuel blends

Work plans addressing the expectations

- In coproduction of biocrude, biocarbon and biogas transportation fuel the biocrude product needs extensive upgrading to be used as transportation fuel. Therefore mild upgrading and alternative applications for the biocrude shall be addressed.
- The work on developing a two-step pyrolysis process for producing a biocrude quality suitable as "drop in" fuel in marine or aviation fuel blends started in 2020 and will continue in 2021. Fuel characteristics of upgraded biocrude and blending properties will be addressed.

WP2.2 Hydrothermal liquefaction

Target: Increase feedstock flexibility – Eliminate or reduce the feedstock effect on the biocrude quality

Processing: Feeding, reactor design, separation

Alternative pretreatment for biological processes

Approach:

1. Experimental work state-of-the-art continuous conditions
2. Modelling – fate of inorganics

   → on hold, we need better experimental data

Continuous HTL processing reactor, ideal for high moisture content

Reactor type: Continuous CSTR reactor
– internal volume 1000 ml
– internal diameter 80 mm
– internal height 200 mm
– up to 6 corrosion samples per experiment
Feed capacity: 0.5-2 L/h, slurry feeding with dual pumps
State-of-the-art operating conditions
– 500 °C
– 350 bar
Products: Biocrude for upgrading

BL2F
Transforming Black Liquor to Biofuel

BIO4 FUELS

WP 2.2 HTL - Highlights

- The HTL reactor is operative – milestone is achieved
- First successful experiment is performed
  - 5% wood powder, 400 °C, 300 bar
  - Steady state with no operator input needed
  - Oil yield: 26.6% DM weight based (includes unrecovered oil on glass walls, etc)
- Experiments are ongoing
  - Collaboration with Aalborg university
  - Wood powder and microalgae or lignin as feedstock
  - Publication planned Q2/Q3 2021

Feedstock

Product

BL2F

Transforming Black Liquor to Biofuel

Black Liquor to Fuel (BL2F) is a 3-year H2020 project that will transform **Black Liquor** into a new, clean biofuel for aviation and shipping

Coordinator: Tampere University

Brunel University London · KIT Karlsruhe Institute of Technology · SINTEF · PAUL SCHERRER INSTITUT PSI · VTT · THE NAVIGATOR COMPANY · Valmet · NESTE · Ranido · LGi sustainable innovation

Find out more and connect with us!

www.bl2f.eu

hello@bl2f.eu

@BL2F_EU

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The Challenge

Aviation and **shipping** sectors are expected to grow at an incredibly fast rate, and so will their **greenhouse gas emissions**

The Goal

BL2F (Black Liquor to Fuel) will create a **new, clean fuel** to be used as an alternative to current fossil fuels

The Method

Using a side-product of the pulp-and-paper industry: **Black Liquor**, BL2F will create an end-to-end chain chain to produce a biofuel **ready to be used in plane and ship engines**

The Impacts

Raise awareness of biofuels

Develop a **low-cost, low-emission fuel**

Create jobs all along the value chain

Help the EU become a **world leader in advanced biofuels**

This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Grant Agreement n°884111.

CENTRE FOR ENVIRONMENT-FRIENDLY ENERGY RESEARCH
The Research Council of Norway

WP2.2 HTL: addressing expectations in 2021

Stakeholder expectation: Publications

- Publications are planned
- experiments ongoing right now – publication Q2/Q3
- New experiments 2021

Stakeholder expectation: Experiments with industrially relevant feedstock and conditions

- Experiments planned 2021 – relevant feedstock received

Stakeholder and internal expectation: Delivery of HTL oil samples to WP2.3

- Planned

WP2.3 Biocrude upgrading

Target: Upgrading of low quality crude bio oils into energy-dense, stable and ash-free oils

Approach:

1. Use of refinery-based hydrotreatment catalysts
   → Matching of oil and catalyst properties for long term activity
2. Development of alternative processes using low-cost catalysts
3. Development of novel electrochemical upgrading processes

Highlights from WP2.3 Biocrude upgrading

Bio4Fuels stakeholder involvement:

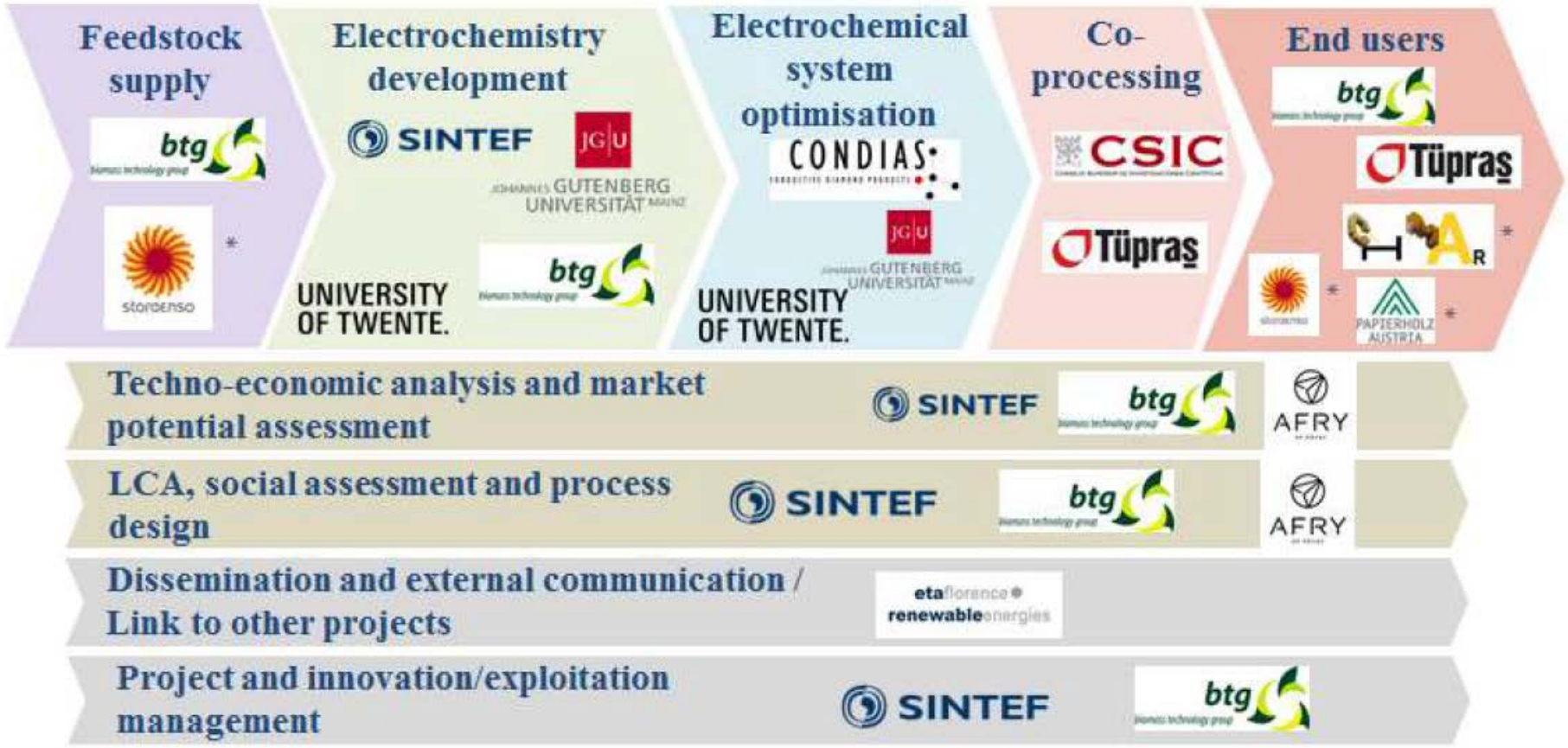
Progress updates with Silva Green Fuels, Biozin, Equinor jointly with WP2.2.

Publications:

- Presentation: Catalytic upgrading of bio oils, 61st International Scientific Conference section “Bioenergy Technologies and Biotechnologies”, Riga Technical University, 2020-10-20.
- Presentation: Thermochemical and Catalytic Lignin conversion routes to fuels and chemicals, Liberate Project Online Webinar, 2020-06-30.
- Book chapter: Pietro Bartocci, Roman Tschentscher, Yunjun Yan, Haiping Yang, Gianni Bidini, Francesco Fantozzi. Biofuels: Types and Process Overview. In Biofuel Production Technologies: Critical Analysis for Sustainability, Editors Neha Srivastava Manish Srivastava, P. K. Mishra, Vijai Kumar Gupta. pages 1-36. Springer, 2020.

Highlights from WP2.3 Biocrude upgrading

New H2020 Project coordinated by SINTEF:
EBIO - Biofuels through Electrochemical transformation of intermediate BIO-liquids



WP2.3 Upgrading: addressing expectations in 2021

Stakeholder expectations:

→ To get an overview about the routes, state-of-the-art and challenges for crude bio-oil upgrading prior to refinery co-processing.

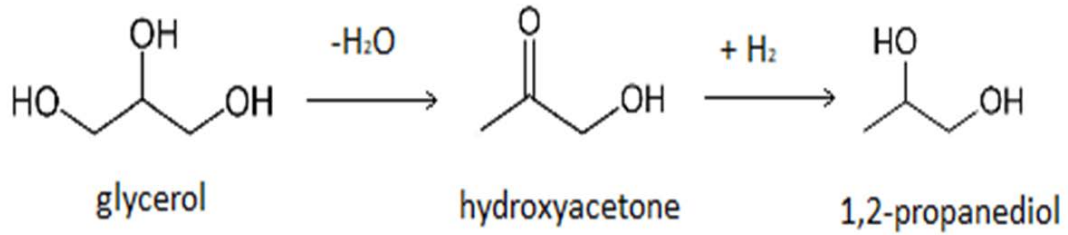
The WP addresses the challenges of bio-oil upgrading jointly with various projects:

→ Related H2020 projects focussing on refinery-based hydrotreatment processes and electrochemical upgrading routes.

→ Within Bio4Fuels slurry processes using low cost upgrading catalysts.

WP 2.4. Catalytic conversion of biomass to chemicals - **Key Research Tasks**

Sugar-to-biochemicals solution for production of monoethylene glycol

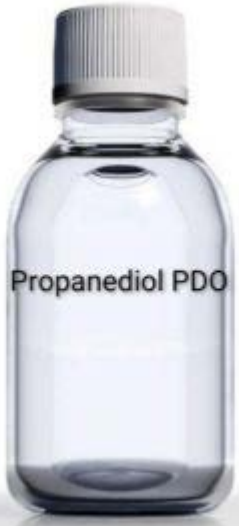


Crude sugar
Biodiesel byproducts

polyester resins,
pharmaceuticals,
tobacco humectants,
paints,
cosmetics,
deicing,
Coolants
and antifreeze

Highlights of WP2.4 Catalysis

New Cu catalyst developed



Active, high selectivity (>95%), stable, no deactivation observed within 50 hrs

- Process of Cu catalyst preparation was developed
- Cu/carbon nanofiber catalysts are highly active, selective and stable for hydrogenation of oxygenates
- Fundamental understanding of Cu catalysts in terms of particle size and support effects on the reaction has been achieved
- Kinetic model of acetol hydrogenation is developed.

WP2.4 addressing expectations in 2021

Value added chemicals from upgrading of oxygenates streams via selective catalytic hydrogenation

- ✓Peer-reviewed publications on the properties controlling catalyst activity
- ✓PhD thesis
- ✓HT has moved the project to pilot plant and focus in the project will bed changes and other stack holds will be involved in WP.

WP2.4 addressing expectations in 2021

Goals in 2021 and beyond:

- Develop catalytic co-pyrolysis of biomass and plastic to stabilized biooil for coprocessing in refinery to produce fuels
- Stakeholders involved: Equinor, HT….

Objectives:

- Produce the stabilized biooils, which can be directly as the feedstock in refinery
- Develop cost effective catalysts for co-pyrolysis

Fluidized bed catalytic pyrolizer NTNU

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Thank you for your attention!

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